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Request for the grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
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1. Your reference

RSJ05825GB

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2. Patent application number
(The Patent Office will fill in this part)

01 OCT 1998

9821375.4

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3. ~~Full name, address and postcode of the or of~~ each applicant *(underline all surnames)*

~~The Welding Institute~~
Abington Hall
Abington
Cambridge
CB1 6AL
GREAT BRITAIN

Patents ADP number *(if you know it)*

71426001

If the applicant is a corporate body, give the country/state of its incorporation

Great Britain

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4. Title of the invention

WELDING METHOD

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5. Name of your agent *(if you have one)*

GILL JENNINGS & EVERY

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Broadgate House
7 Eldon Street
London
EC2M 7LH

Patents ADP number *(if you know it)*

745002

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6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

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8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
a) any applicant named in part 3 is not an inventor
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

YES

WELDING METHOD

The present invention relates to a method of forming a weld between two workpieces, over a joint region.

Transmission laser welding is a technique which has been developed for welding together materials such as plastics. This is achieved by positioning two plastic members in contact, one of which is transparent, the other of which is opaque to visible light. The region of contact between the two plastic members is then exposed to a laser beam. The laser beam passes through the transparent plastic member and is absorbed by the second opaque plastic member. This causes the opaque plastic member to heat up causing the region of contact between the two plastic members to melt, thereby forming a weld. Examples are described in "Laser-transmission welding of PE-HD", Kunstoffe 87 (1997) 3, pp 348-350; Puetz H et al, "Laser welding offers array of assembly advantages", Modern Plastics International, September 1997; Haensch D et al, "Joining hard and soft plastics with a diode laser", Kunstoffe 88 (1998) 2, pp 210-212; and Jones I A, "Transmission laser welding of plastics", Bulletin of The Welding Institute, May/June 1998.

All these methods are limited by the need to provide at least one workpiece which is opaque to visible light.

In accordance with the present invention, we provide a method of forming a weld between workpieces over a joint region, the method comprising exposing the joint region to radiation having a wavelength outside the visible spectrum, and welding the workpieces together, the method further comprising providing a material at the joint region in one of the workpieces or between the workpieces which absorbs the incident radiation to generate heat for the process and which does not affect the appearance of the joint region or the workpieces in visible light from the appearance without the material.

heating is localised to the interface between the two workpieces.

Typically, the radiation having the predetermined wavelength is infrared radiation, for example with a wavelength of substantially 780nm or more, typically up to 1500nm. It will however be realised that any radiation outside the visible spectrum may be used providing a suitable radiation absorbing material is available, and, if appropriate, one side of the joint is transmissive to the radiation used.

A variety of conventional radiation sources may be used including both diode and Nd:YAG lasers. Focused infrared lamps could also be used.

Examples of methods according to the present invention will now be described with reference to the accompanying drawings, in which:-

Figures 1 to 3 are schematic side views of three different welds.

Figure 1 shows a first plastics workpiece 1 and a second plastics workpiece 2 positioned in overlapping contact so as to define a joint region indicated at 3. The joint is welded by exposing the joint region 3 to a beam of non-visible radiation 4 from a source such as a laser 5, an i.r. lamp or the like.

The first plastics workpiece 1 is transmissive to radiation from the radiation beam 4 and may or may not transmit visible light. In this respect, transmissive means that the plastics workpiece 1 absorbs less than a predetermined portion of the incident radiation. Accordingly, the plastics workpiece 1 may be transparent or translucent to radiation in the visible spectrum, or may reflect such radiation but typically will not be totally absorbent (ie. black). Thus, the plastics workpiece 1 will be either colourless, clear with a coloured tint, or coloured.

The plastics workpiece 2 also may or may not be transmissive to radiation in the visible spectrum.

not be transmissive to radiation in the visible spectrum. However, in contrast to the first embodiment, it is not necessary for the second plastics workpiece 12 to absorb the radiation from the radiation beam 14.

However, the weld film 16 whilst being transmissive to radiation in the visible spectrum is absorptive to radiation from the radiation beam 14. Thus, as in the first embodiment of the present invention, when the joint region 13 is exposed to the radiation beam 14, the weld material 16 absorbs heat causing heating of the surrounding joint region 3. Consequently the plastics workpieces 11,12 melt in the joint region 13 and on cooling form a weld. Again this is optically transmissive to radiation in the visible spectrum.

In its most basic form absorption in a translucent material follows an exponential link to thickness (ignoring the effects of reflection and scattering), i.e.

$$\text{fraction transmitted} = \exp(-at)$$

where a is the absorption coefficient and t is the thickness of the workpiece. The absorption coefficients for the translucent plastics we have measured range from 0.02mm^{-1} to 0.4mm^{-1} at 800-1100nm wavelength. Thus a useful range is anything less than about 1mm^{-1} for a translucent plastic. In a process of the form shown in Figure 2, the layer of dye had an absorption coefficient of about 5.4mm^{-1}. Typically, therefore, the absorptive layer should have an absorption coefficient greater than about 3mm^{-1}.

It will be realised that in either of the above examples, the plastics workpieces 1,2; 11,12 may be clamped together during the welding process to ensure the joint region is maintained in contact while the weld forms. Alternatively, the component with the absorptive material may be irradiated first and then the workpieces brought together.

CLAIMS

1. A method of forming a weld between workpieces over a joint region, the method comprising:

exposing the joint region to radiation having a wavelength outside the visible spectrum, and welding the workpieces together, the method further comprising providing a material at the joint region in one of the workpieces or between the workpieces which absorbs the incident radiation to generate heat for the process and which does not affect the appearance of the joint region or the workpieces in visible light from the appearance without the material.

2. A method according to claim 1, wherein the radiation absorbing material is sandwiched between two workpieces.

3. A method according to claim 1, wherein the radiation absorbing material is provided in at least one of the workpieces.

4. A method according to any of the preceding claims, wherein the material is exposed to radiation prior to positioning the workpieces together.

5. A method according to any of the preceding claims, wherein the radiation absorbing material is exposed to radiation through one of the workpieces.

6. A method according to any of the preceding claims, wherein the radiation has a wavelength of 780nm or more.

7. A method according to claim 6, wherein the radiation is in the infrared range.

8. A method according to any of the preceding claims, wherein the workpieces are made of plastics.

9. A method according to any of the preceding claims, wherein the material is a radiation absorbing dye.

10. A method of forming an optically transmissive weld between optically transmissive workpieces, over a joint region, substantially as hereinbefore described with reference to the accompanying drawings.

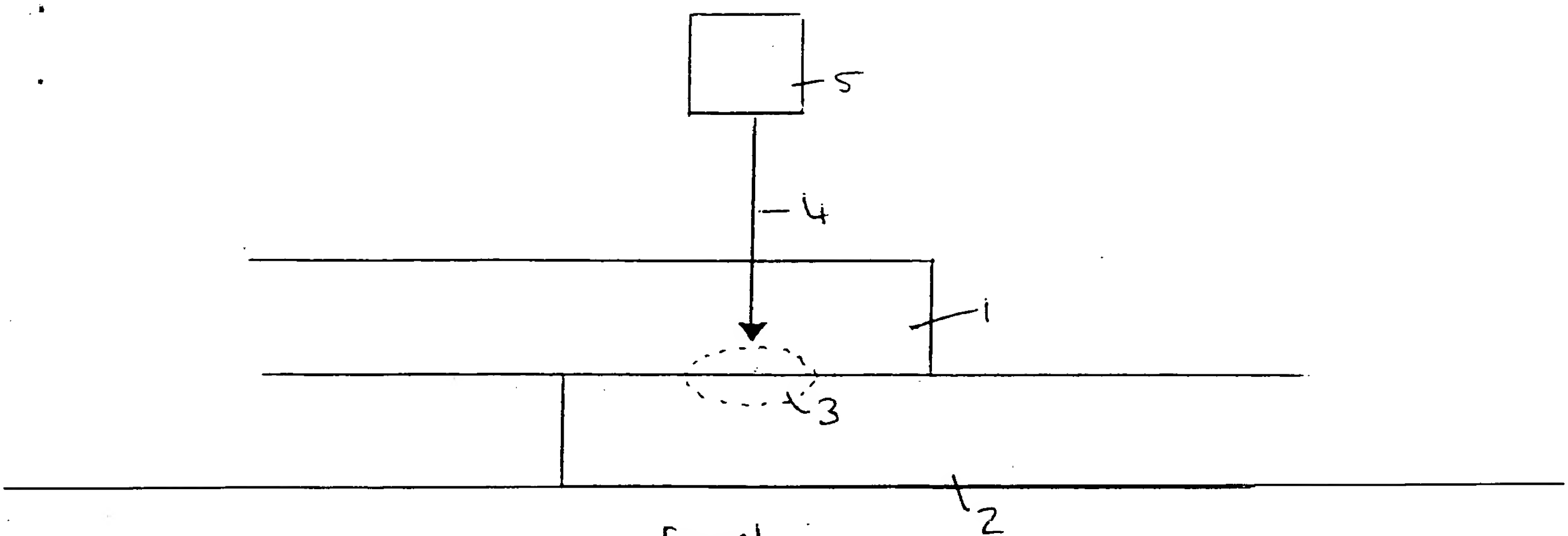

Figure1

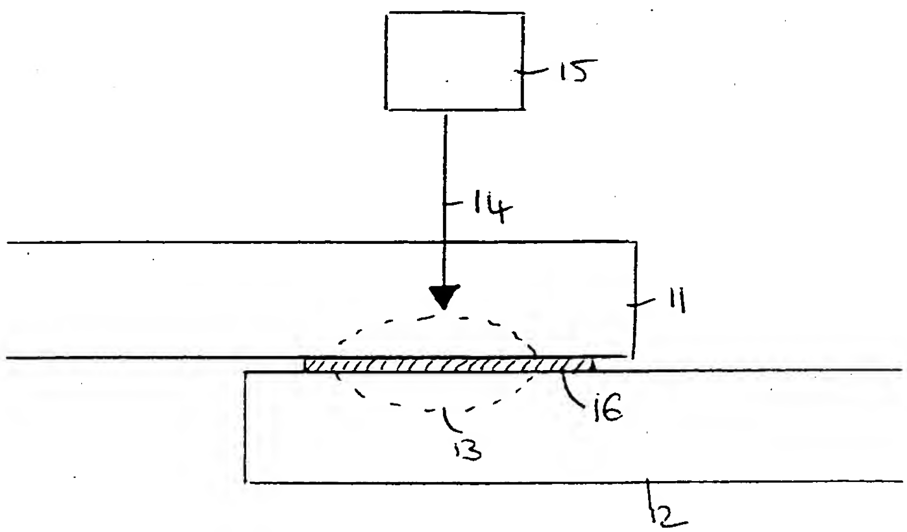

Figure 2

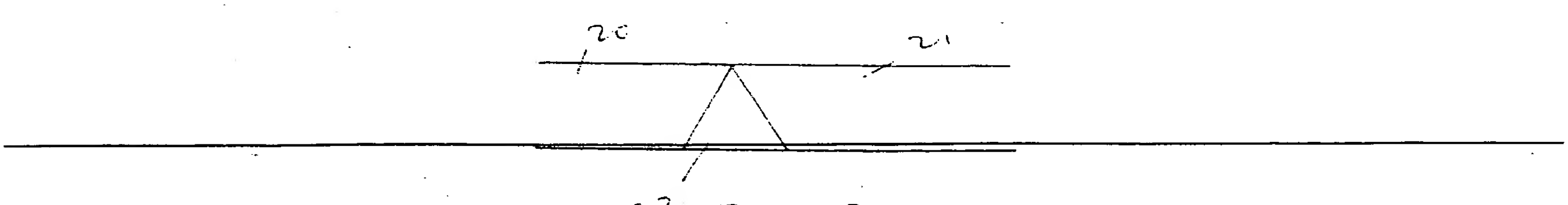

Figure 3